Coral disease investigation at Grecian Rocks

Jan H. Landsberg, Vanessa Brinkhuis, Yasu Kiryu,
Patrick Wilson, Clark Gray, Lindsay Huebner

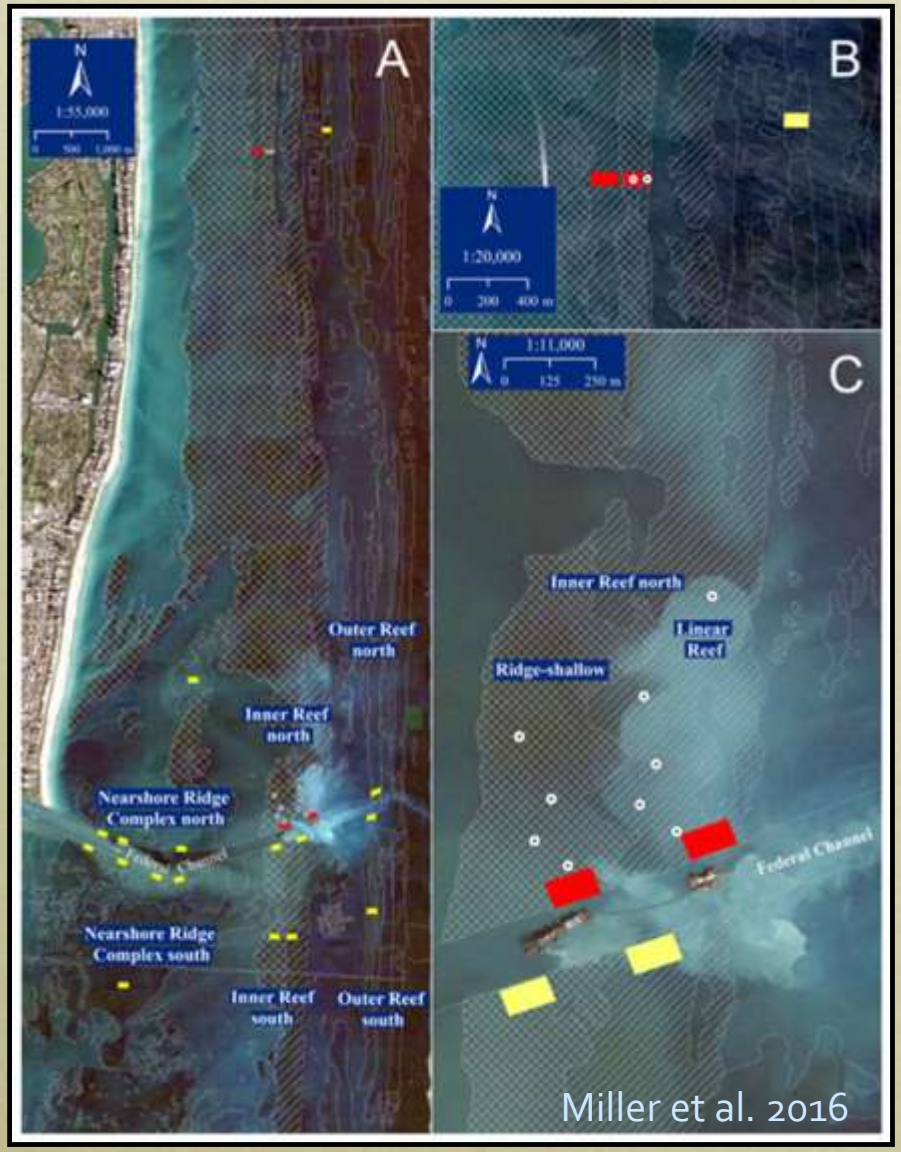
Fish and Wildlife Research Institute
Florida Fish and Wildlife Conservation Commission
St. Petersburg
Florida

Coral disease outbreaks (1)

- initial reports of disease outbreaks offshore Miami in 2014
- outbreaks spread to the north and south
- multiple diseases documented on at least 21 coral species
- confirmed affected areas: Martin, Palm Beach, Broward, Miami-Dade counties, Biscayne Bay (NPS), Upper Keys (FKNMS)

Exacerbating conditions

- coastal construction activities in Miami preceding outbreak event (2014): dredging
- 2014-2016 El Niño: elevated temperature stress and coral bleaching
- chronic anthropogenic impacts from a highly developed coastline



Coral disease outbreaks (2)

Documented diseases

- white plague
- "white blotch"
- "bleaching band"
- indistinguishable white disease

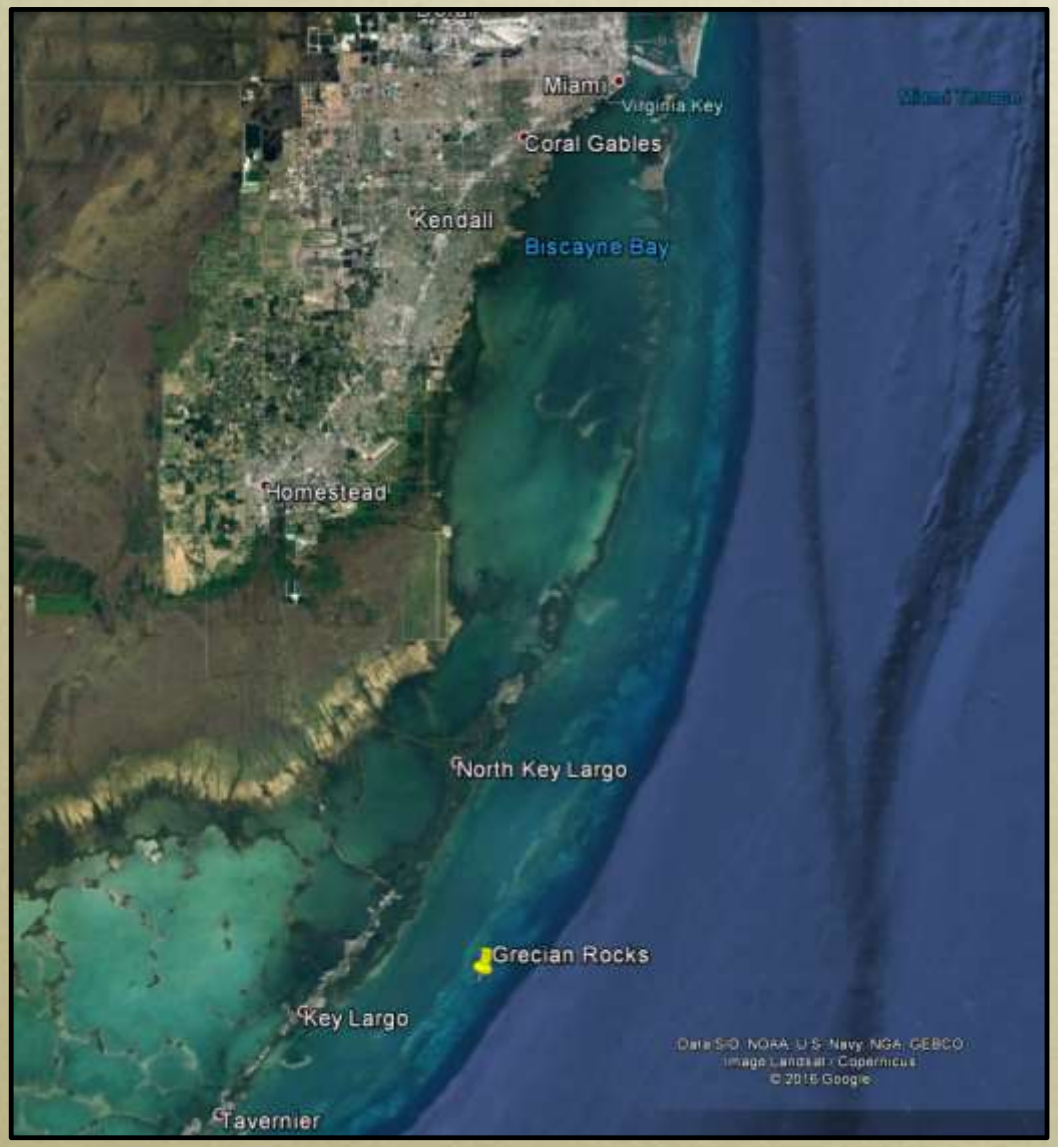
Common species affected

- *Colpophyllia natans*
- *Dendrogyra cylindrus*
- *Dichocoenia stokesii*
- *Diploria labyrinthiformis*
- *Eusmilia fastigiata*
- *Meandrina meandrites*
- *Montastraea cavernosa*
- *Orbicella annularis* complex
- *Pseudodiploria clivosa*
- *Pseudodiploria strigosa*
- *Siderastrea siderea*

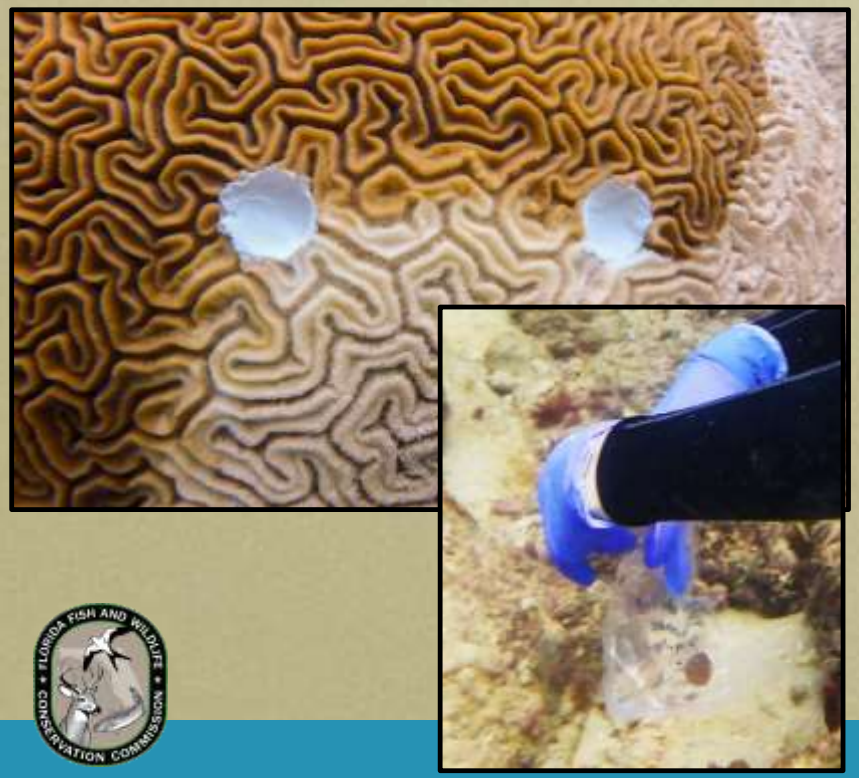
Coral disease outbreaks at Grecian Rocks

- sanctuary Preservation Area (FKNMS) offshore Key Largo
- popular snorkel and dive spot for tourists and locals
- Coral Reef Evaluation and Monitoring Project (CREMP) site since 1996
- outbreak documented during annual CREMP survey July 2016

21-22 July 2016 sample location

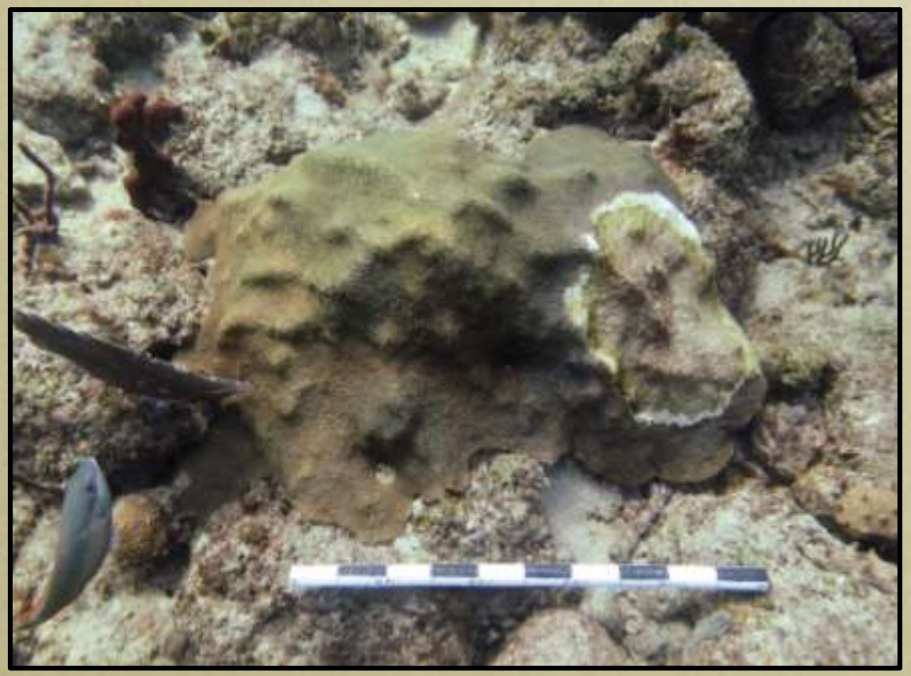


Coral tissue sampling



- 1”diameter stainless steel corers
- minimal cross contamination
- sterilized corers/new gloves/colony
- plugged with epoxy

Sampling strategy



- sets of tissue cores (molecular & histology) from disease margin (if diseased) and unaffected area
- target species: *M. cavernosa*, *S. siderea*, *O. faveolata*, *C. natans* and *D. labyrinthiformis*

White plague (1)

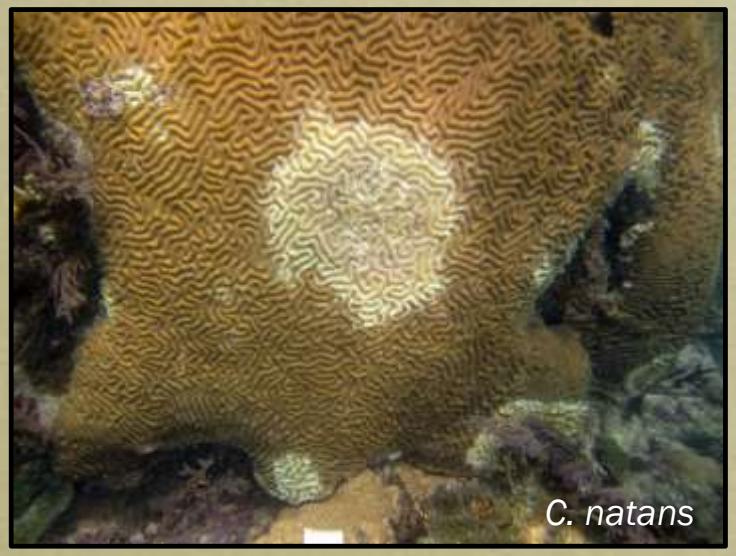
- white band of exposed skeleton with gradient of algal colonization
- lesions (exposed skeleton) have sharp borders of living coral tissue
- fast rate of disease advance
  - large areas of recent mortality
  - low colonization of algae (yellow fuzz)

D. labyrinthiformis

White plague (2)

- highly susceptible species:
  M. meandrites, *D. stokesii*, *O. faveolata*, *M. cavernosa*, *P. strigosa*, *D. labyrinthiformis*, *D. cylindrus*

White blotch (1)



- undescribed white disease
- white expanding rings of exposed skeleton with gradient of algal colonization
- multifocal lesions (exposed skeleton) having sharp and/or irregular borders of living coral tissue
- lesions begin as areas of paling tissue
- moderate rate of disease advance
  - medium areas of recent mortality
  - low algal colonization (yellow fuzz)

White blotch (2)

- highly susceptible species:
  C. natans, *S. siderea*, *M. cavernosa*, *D. labyrinthiformis*

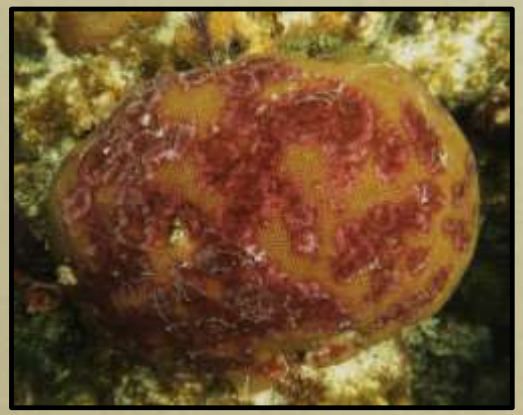

S. siderea

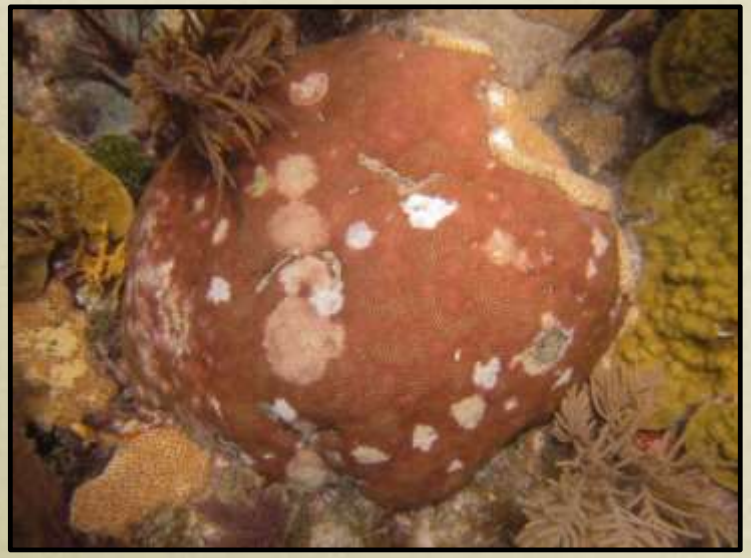

C. natans

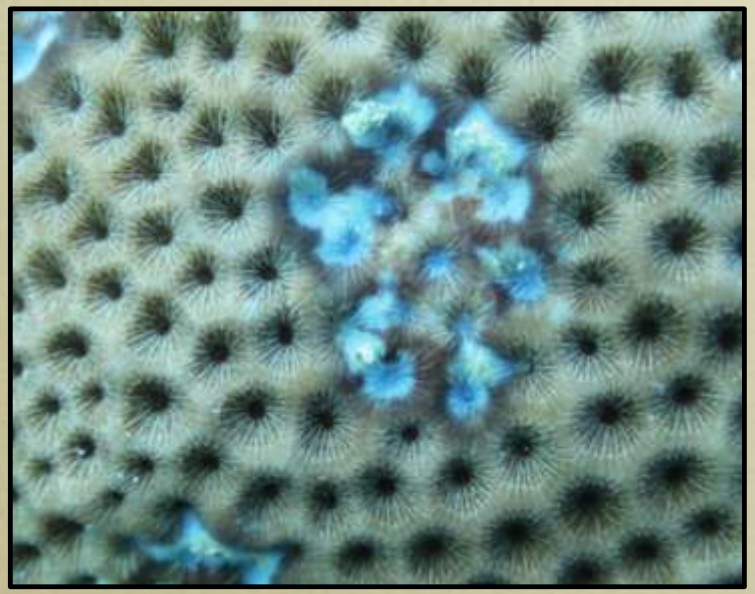

M. cavernosa

White blotch (3) on *Siderastrea*

- *S. siderea* typically considered hardy
- is highly susceptible
- lesion appearance varies # colonies







Bleaching band (1)

- undescribed white disease
- white expanding rings/bands of bleached polyps bordered with gradient of algal colonization
- multifocal lesions (exposed skeleton) with irregular borders of living bleached tissue
- slow rate of disease advance
  - areas of recent mortality
  - moderate algal colonization (dark green-yellow fuzz)
- affected species, *M. cavernosa*, *O. faveolata*

Bleaching band (2)

White diseases prevalence at Grecian Rocks

- prevalence 8.7-100%
- 8 species highly susceptible
- *Porites* spp. less to not susceptible
- other species (small N)

Species	N	N affected*	%
A. agaricia	2	0	0.0
A. fragilis	1	0	0.0
D. stokesii	1	0	0.0
M. cavernosa	4	3	75.0
M. decactis	1	0	0.0
P. astreoides	2	0	0.0
S. siderea	13	13	100.0
Total	24	16	66.7

transect (#10, 1 x 10m) off edge of reef in sand

*includes recently dead, not separated by disease type

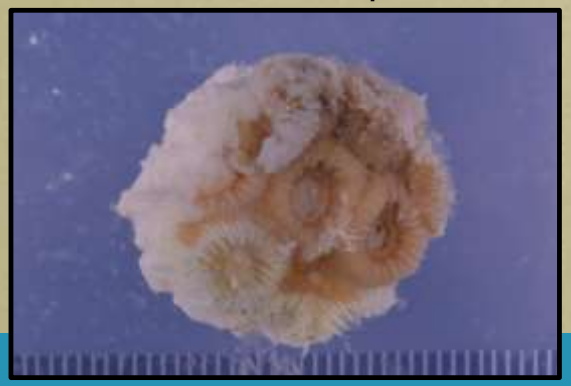
Species	N	N affected*	%
A. agaricia	69	6	8.7
A. fragilis	4	0	0.0
C. natans	3	1	33.3
D. labyrinthiformis	3	2	66.7
D. stokesii	3	1	33.3
E. fastigiata	3	1	33.3
M. cavernosa	15	9	60.0
M. complanata	1	0	0.0
M. decactis	1	0	0.0
M. meandrina	2	2	100.0
M. aliciae	1	0	0.0
O. annularis	2	0	0.0
O. faveolata	2	0	0.0
P. astreoides	159	6	3.8
P. porites	81	0	0.0
P. strigosa	2	1	50.0
S. michelinii	5	0	0.0
S. radians	5	1	20.0
S. siderea	105	42	40.0
Total	466	72	15.5

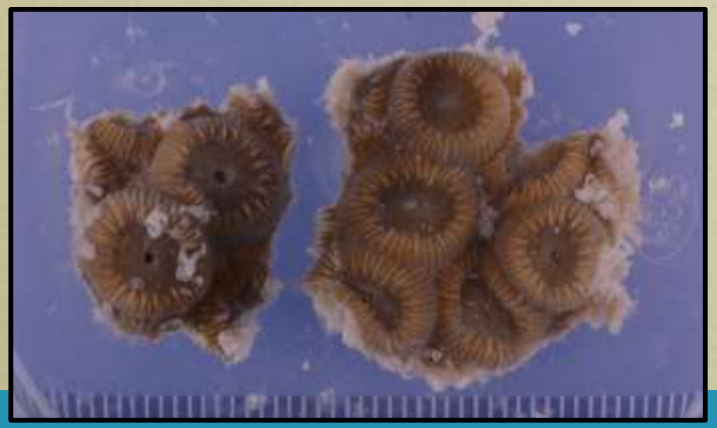
prevalence on 12, 1x10m transects

Montastraea cavernosa, white blotch (1)

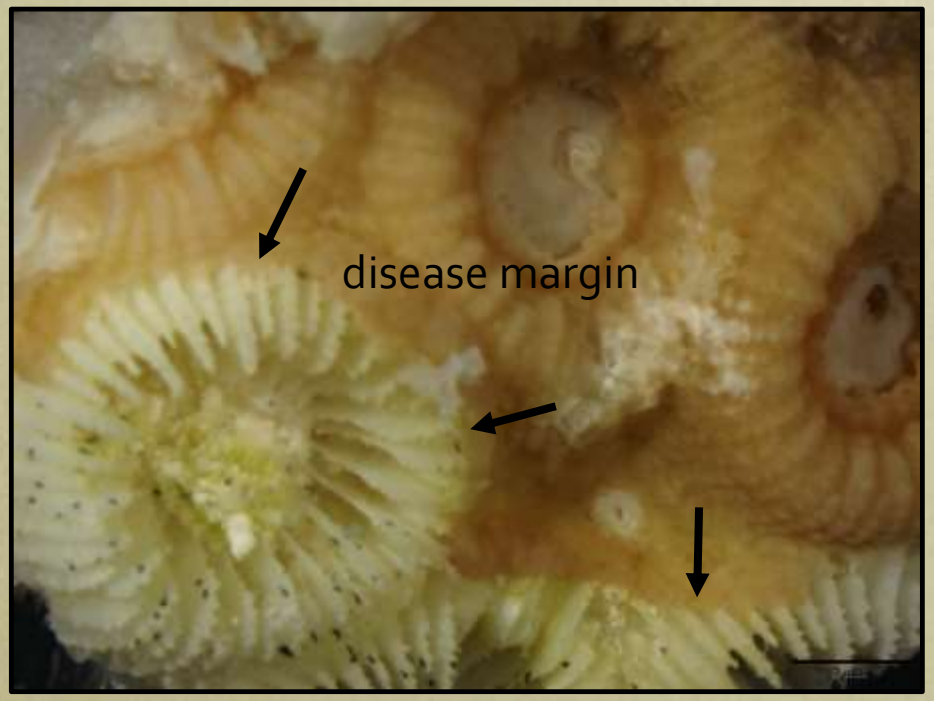
diseased sample

MCAV #12, 7/21/16 unaffected sample



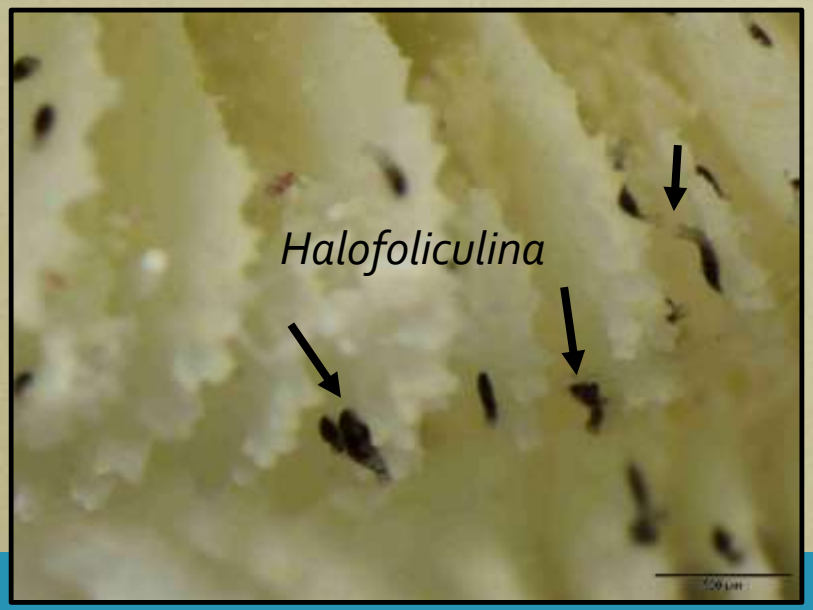


Montastraea cavernosa, white blotch (2)

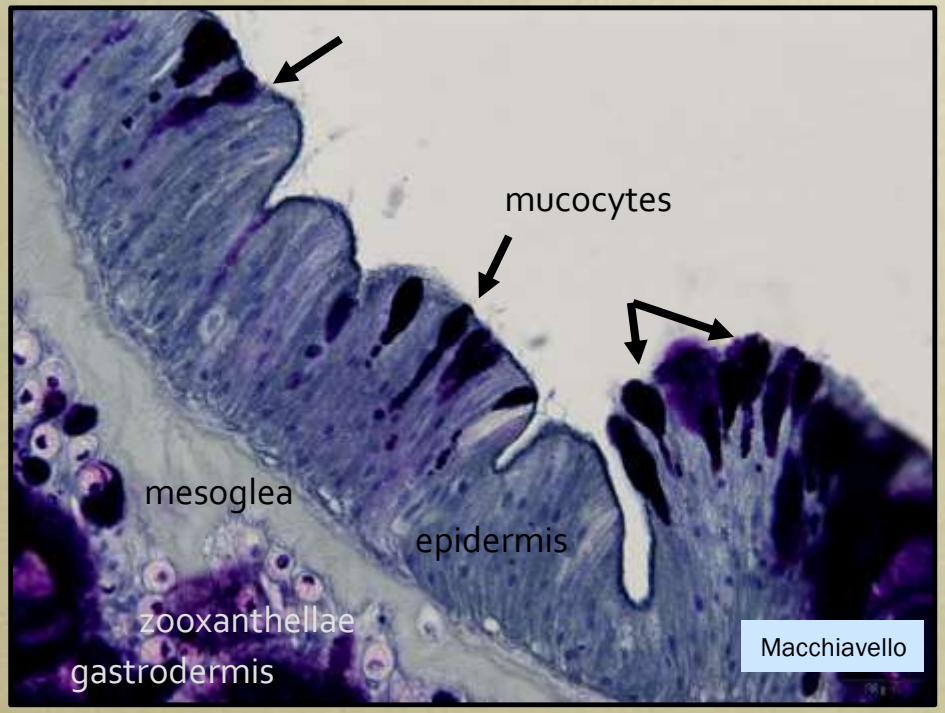


diseased sample

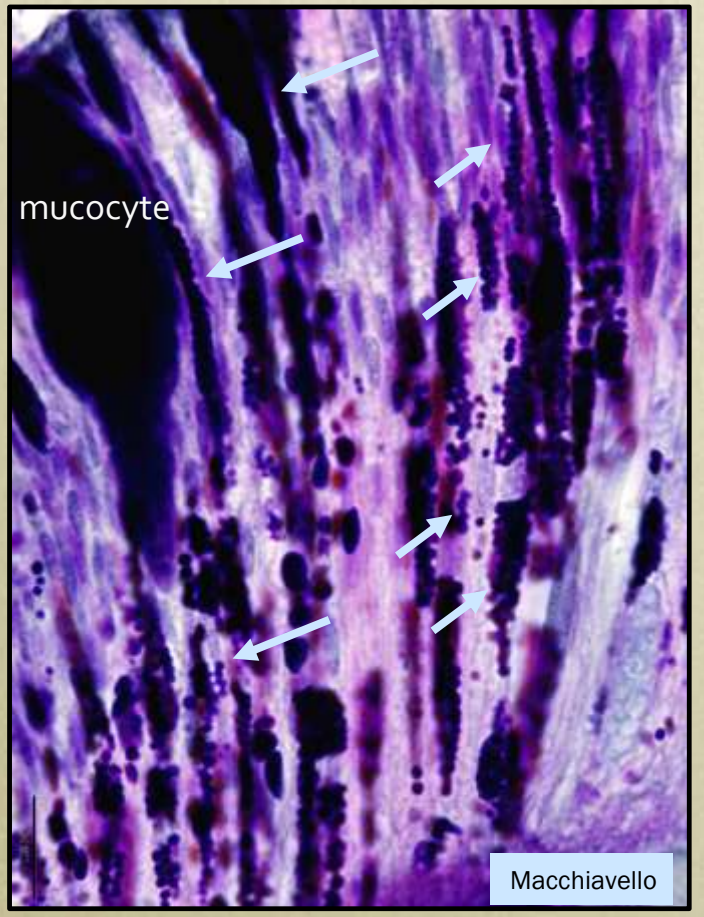
unaffected sample



Montastraea cavernosa, white blotch (3)



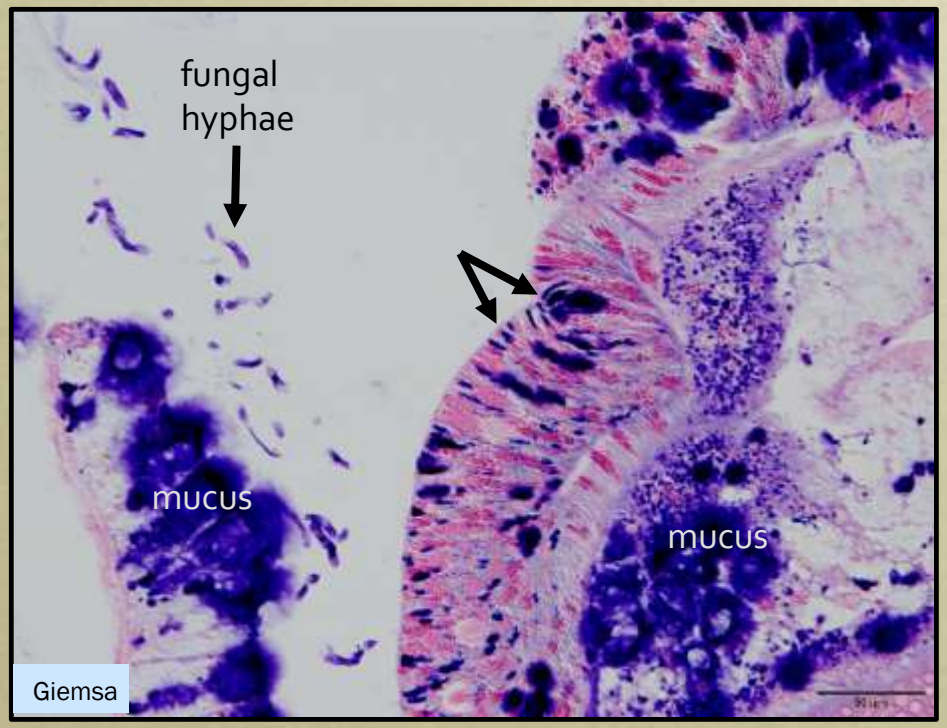
MCAV#12, 7/21/16
unaffected sample

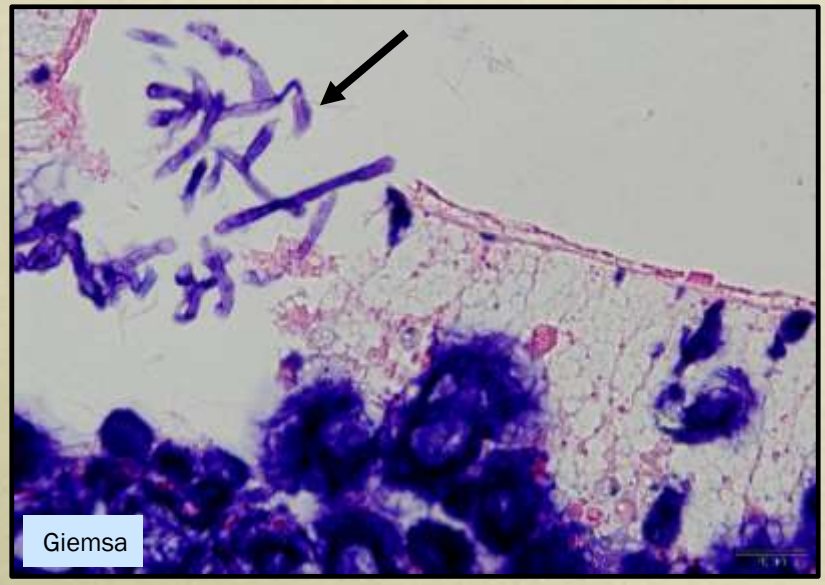


organisms (?) near mucocytes

?chlamydia-like organisms (CLOs)

Montastraea cavernosa, white blotch (4)

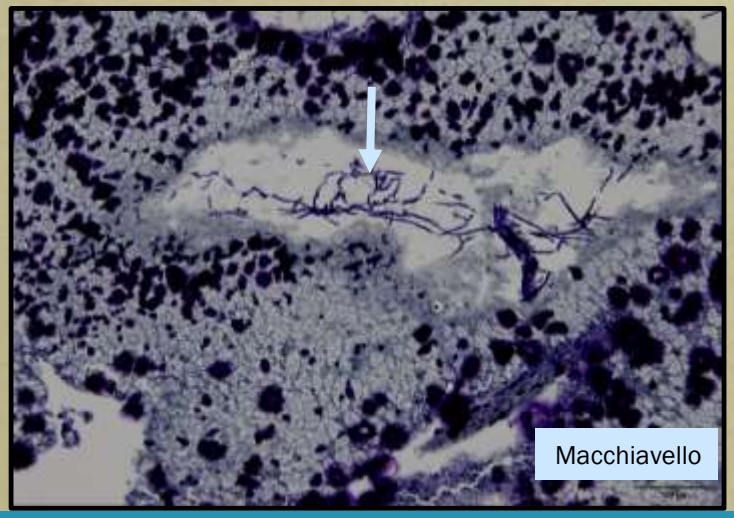


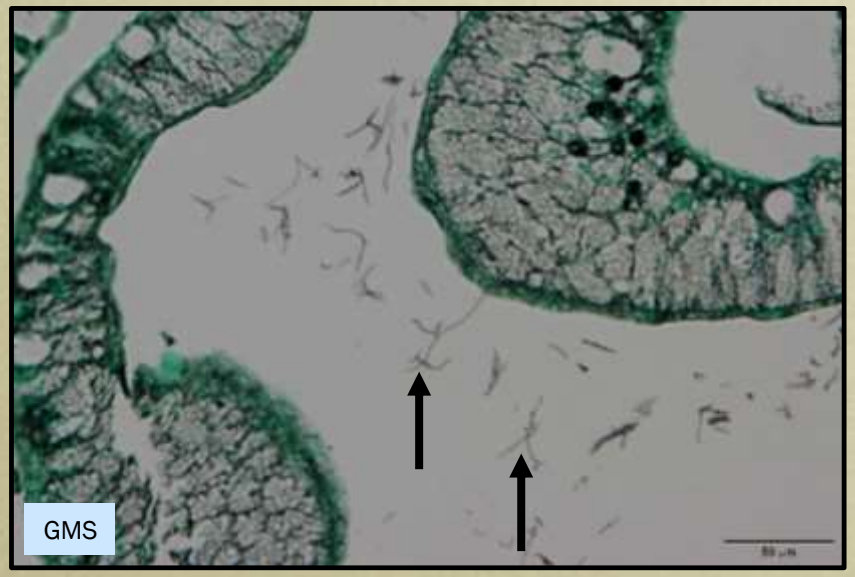


MCAV #12, 7/21/16

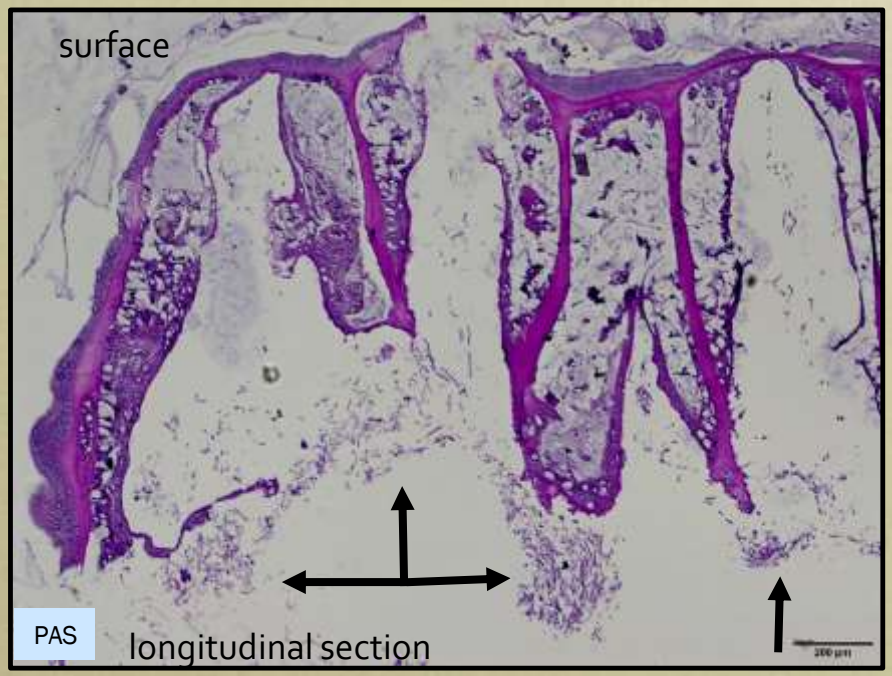
unaffected sample

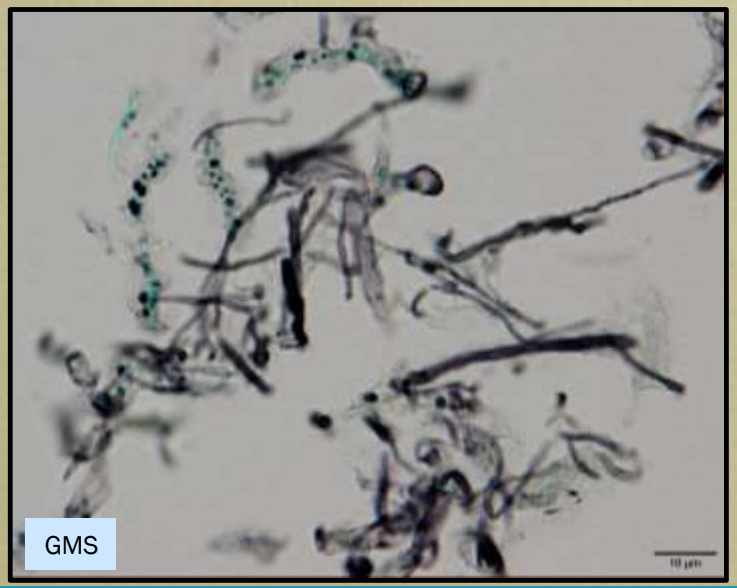
endolithic fungi in skeleton



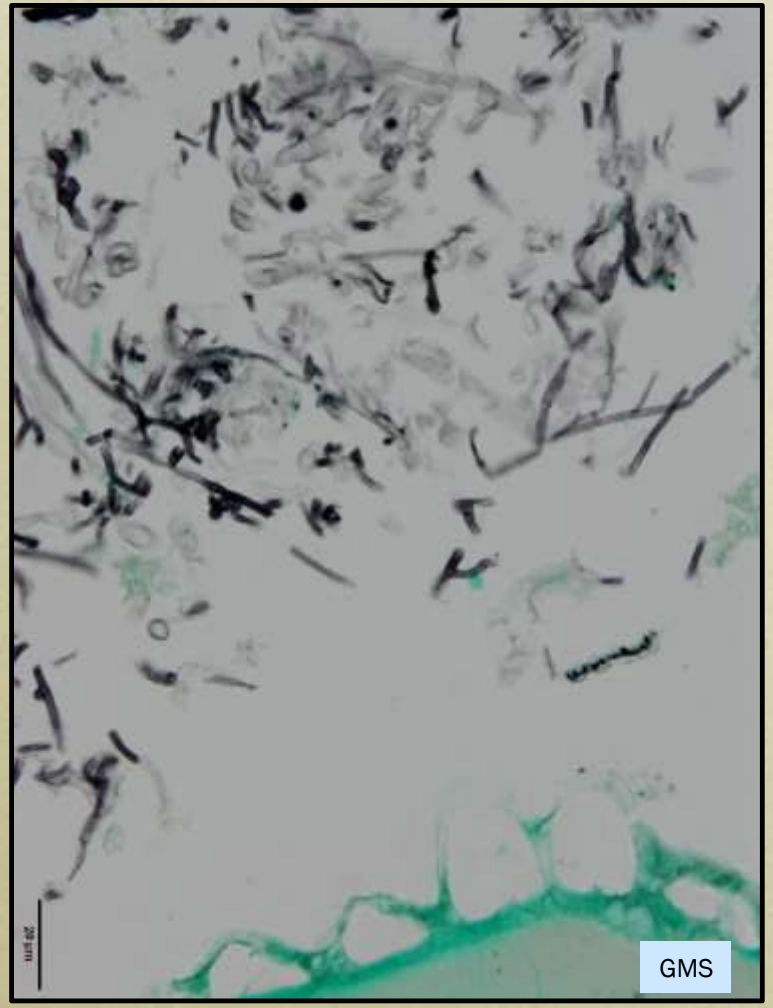


Montastraea cavernosa, white blotch (5)





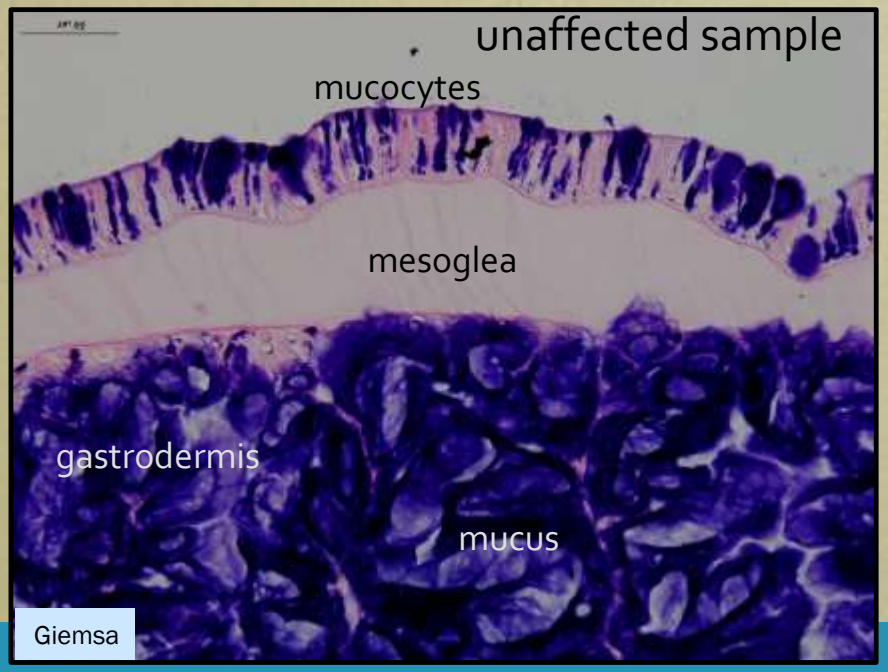
MCAV #12, 7/21/16, diseased sample

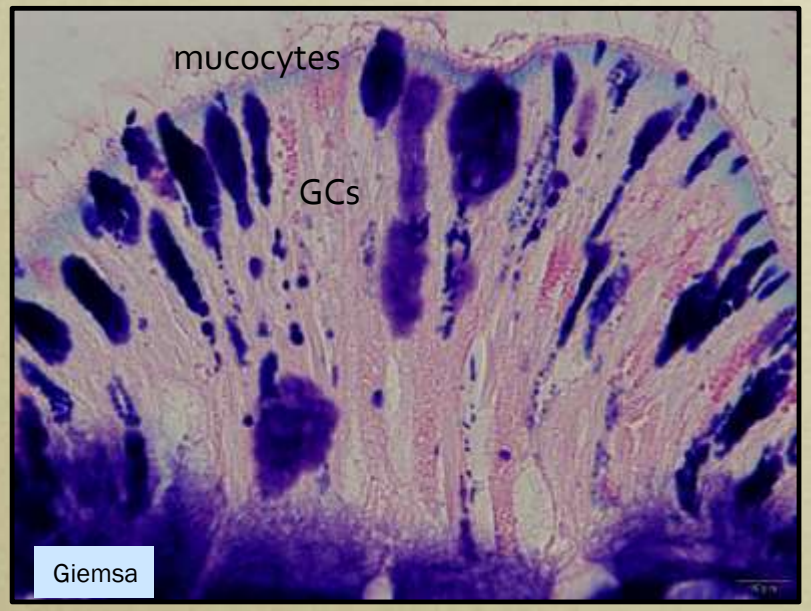


endolithic fungi in skeleton

Montastraea cavernosa, bleached band (1)

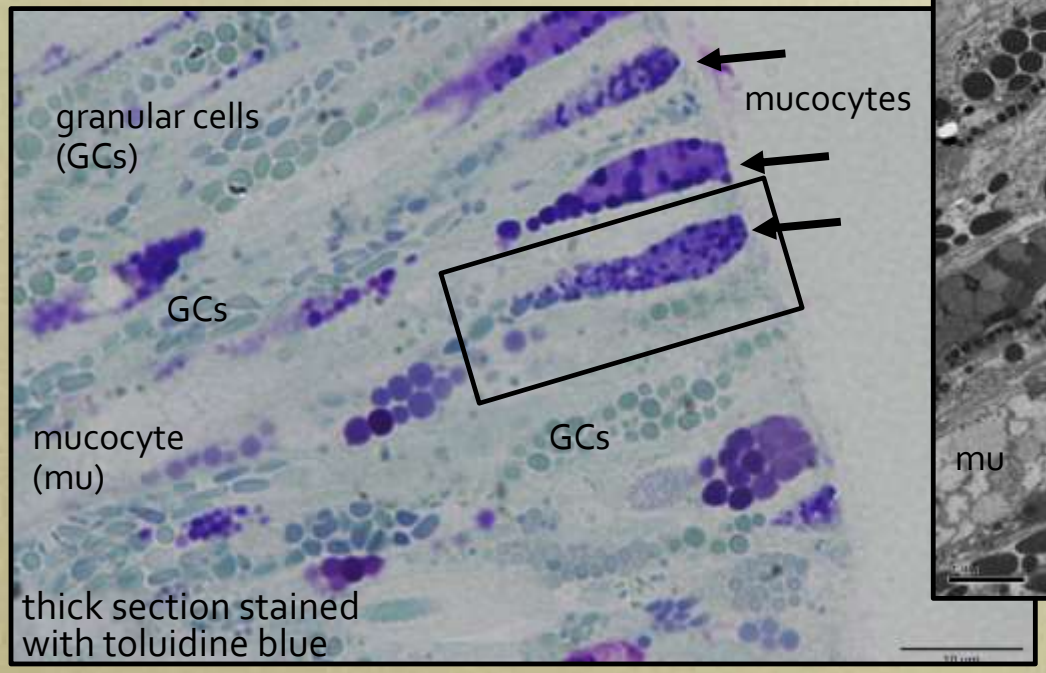
MCAV #16, 7/21/16

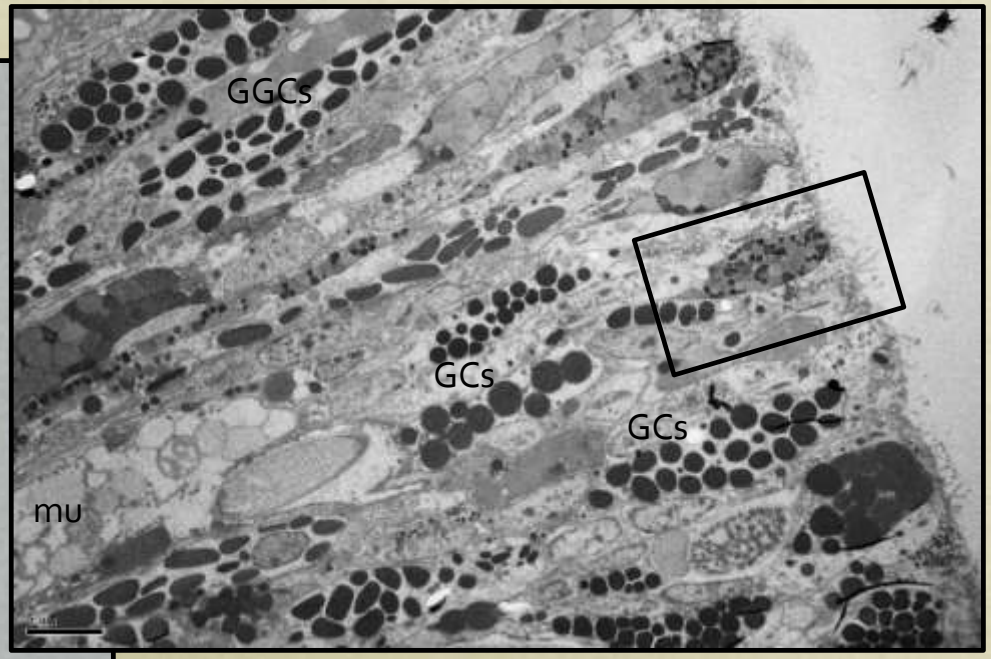




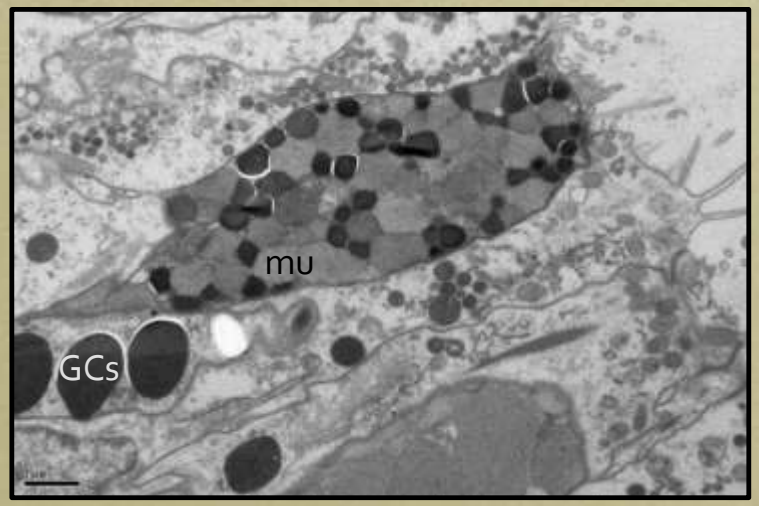
Montastraea cavernosa, bleached band (2)

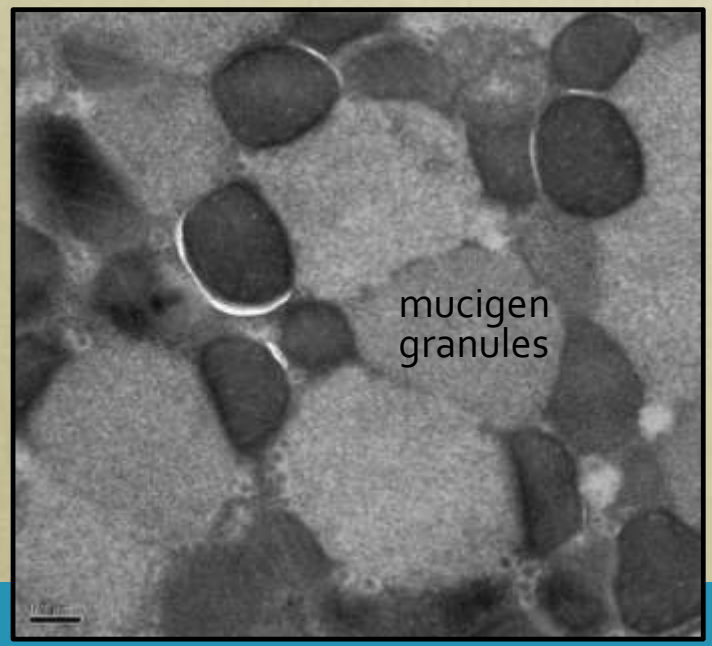
TEM



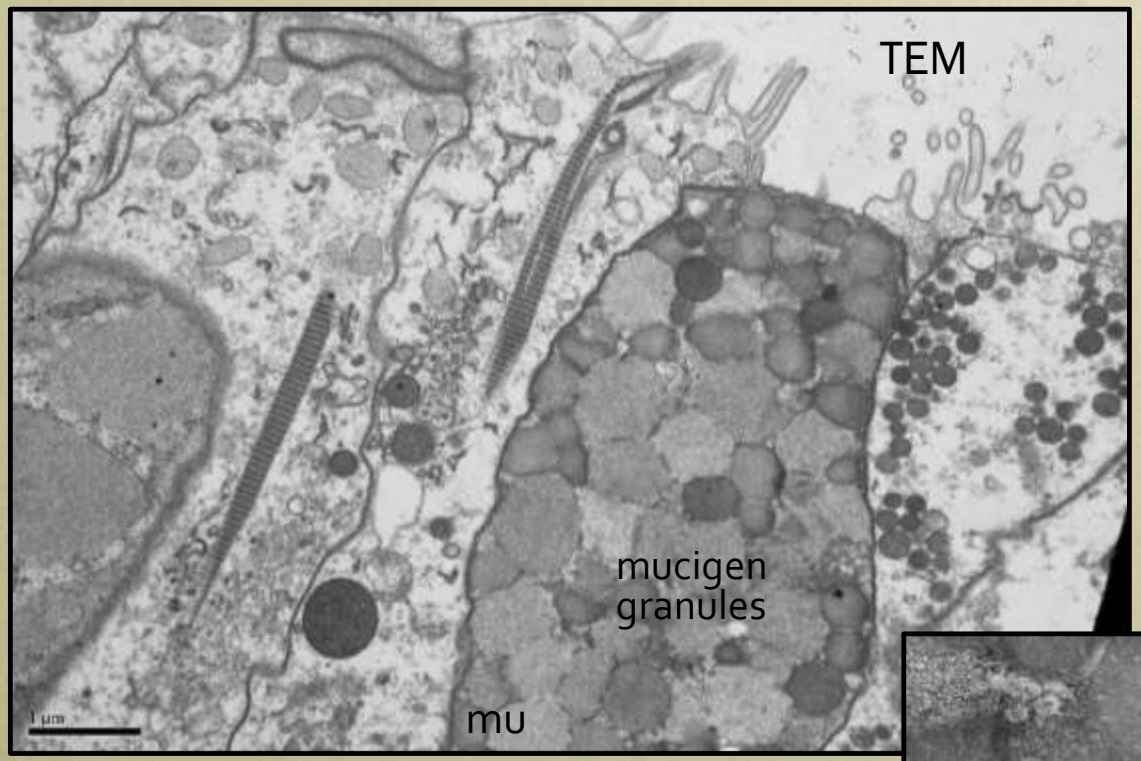


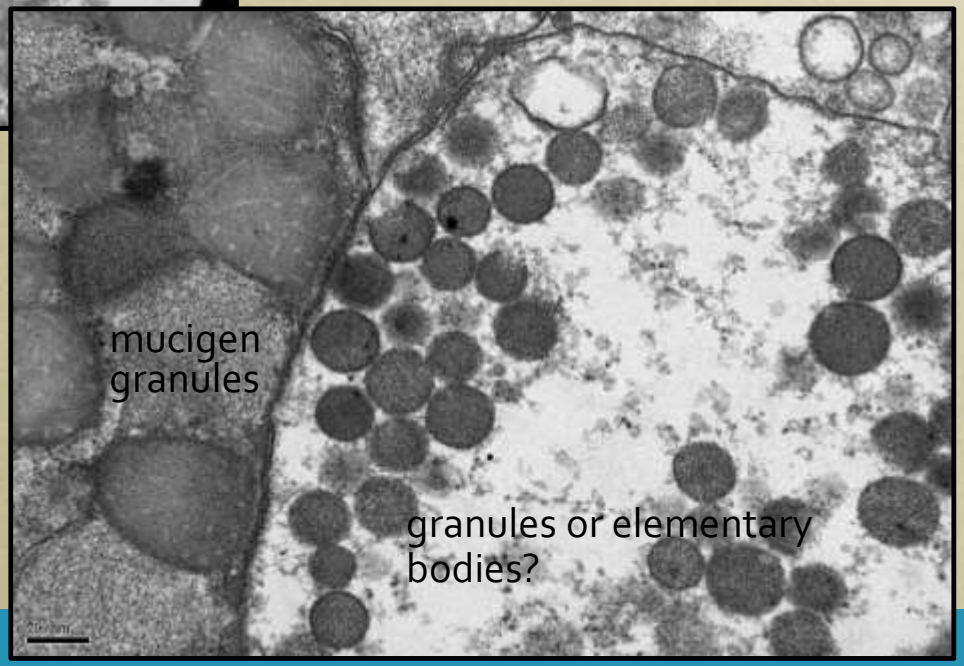
MCAV#16,
7/21/16
unaffected
sample





Montastraea cavernosa, bleached band (3)

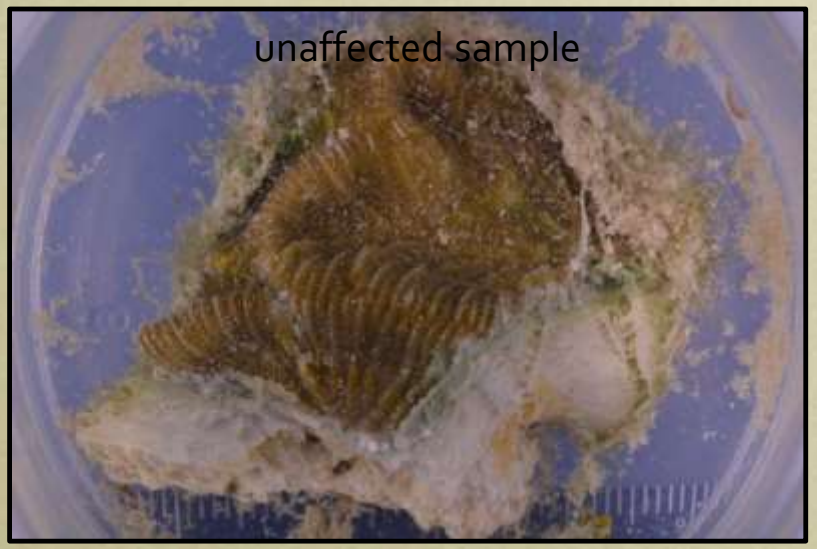




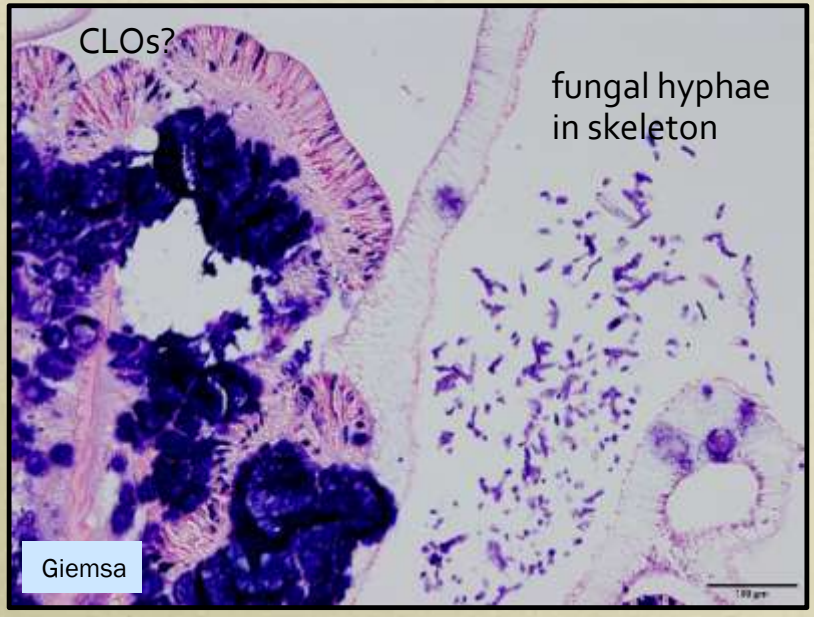
MCAV#16, 7/21/16
unaffected sample

Colpophyllia natans, white plague (1)

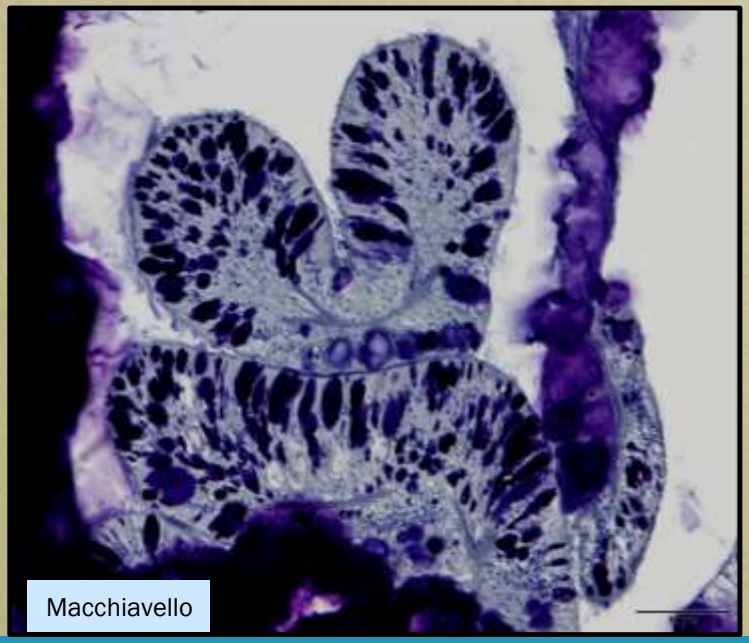
CNAT #15,
7/22/16

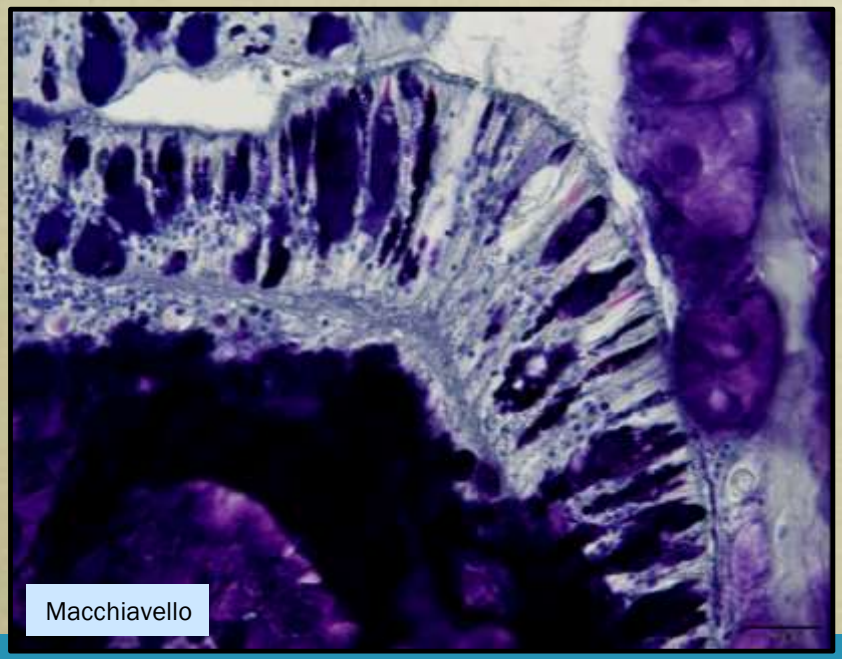


Colpophyllia natans, white plague (2)

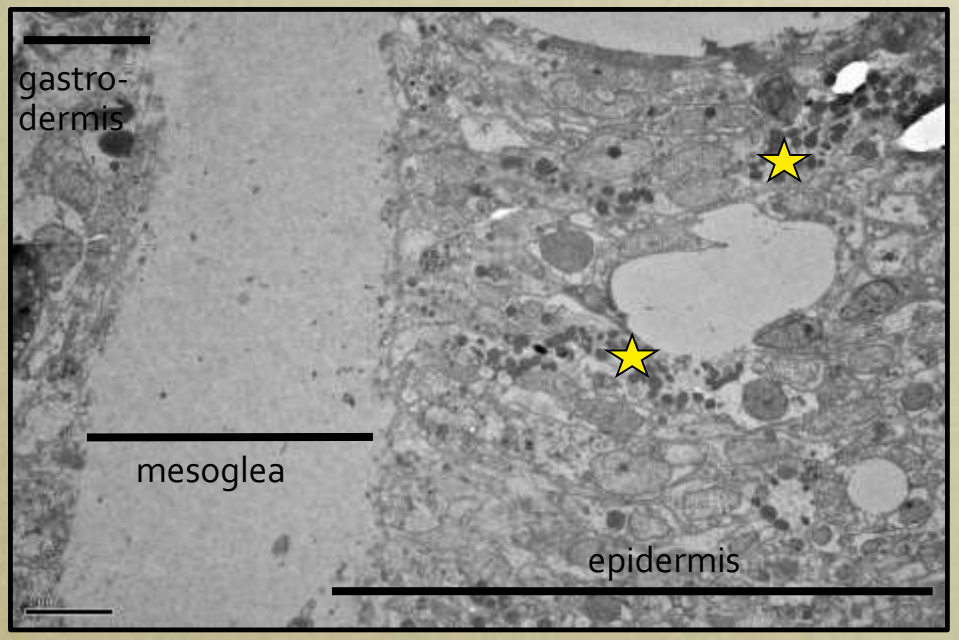


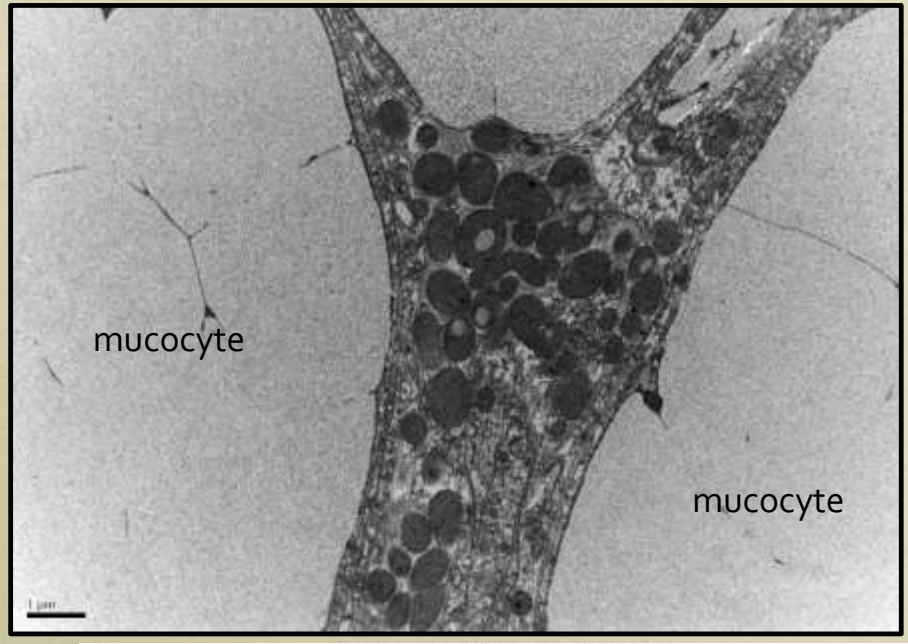
CNAT #15
7/22/16,
unaffected
sample



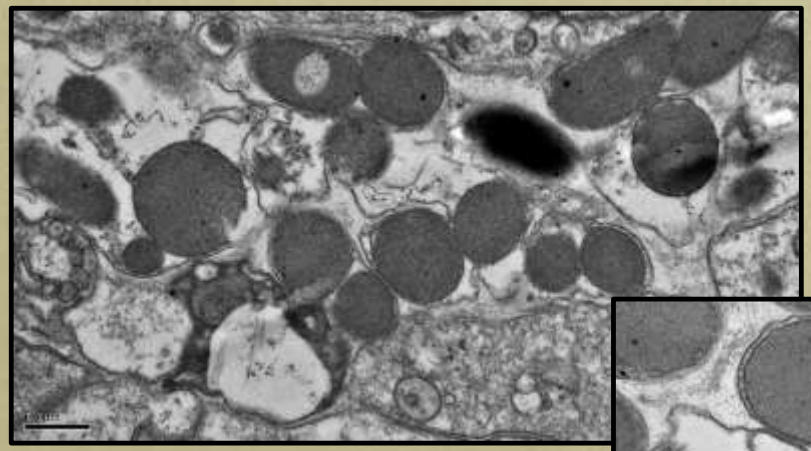


Colpophyllia natans, white plague (3)

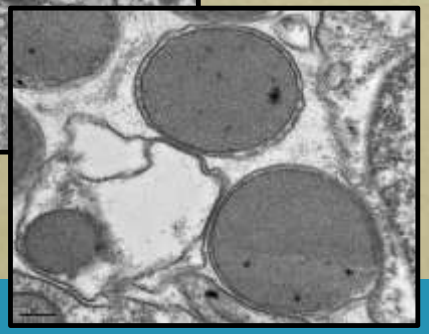




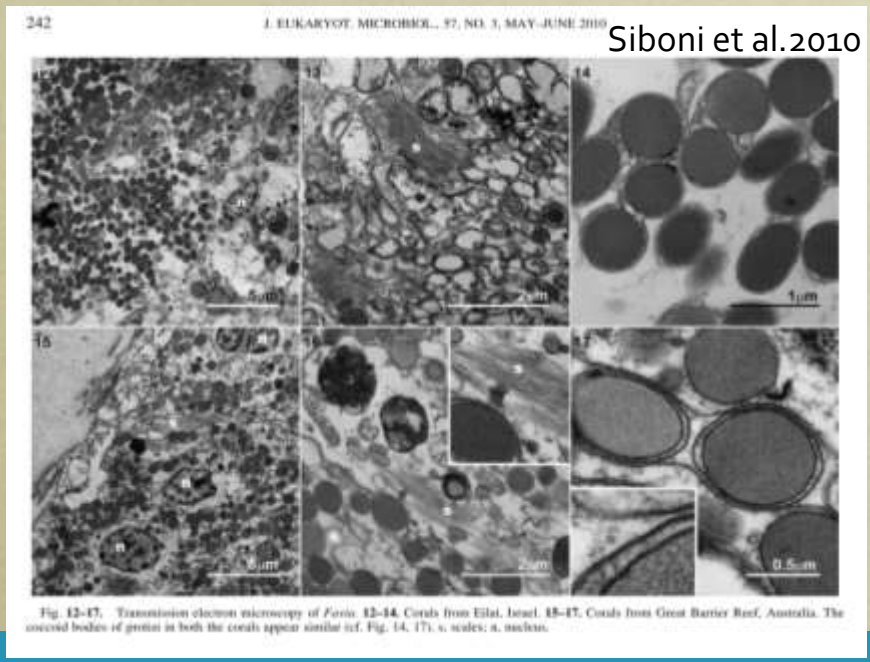
coccoid-like organisms = stramenopiles? (protists)



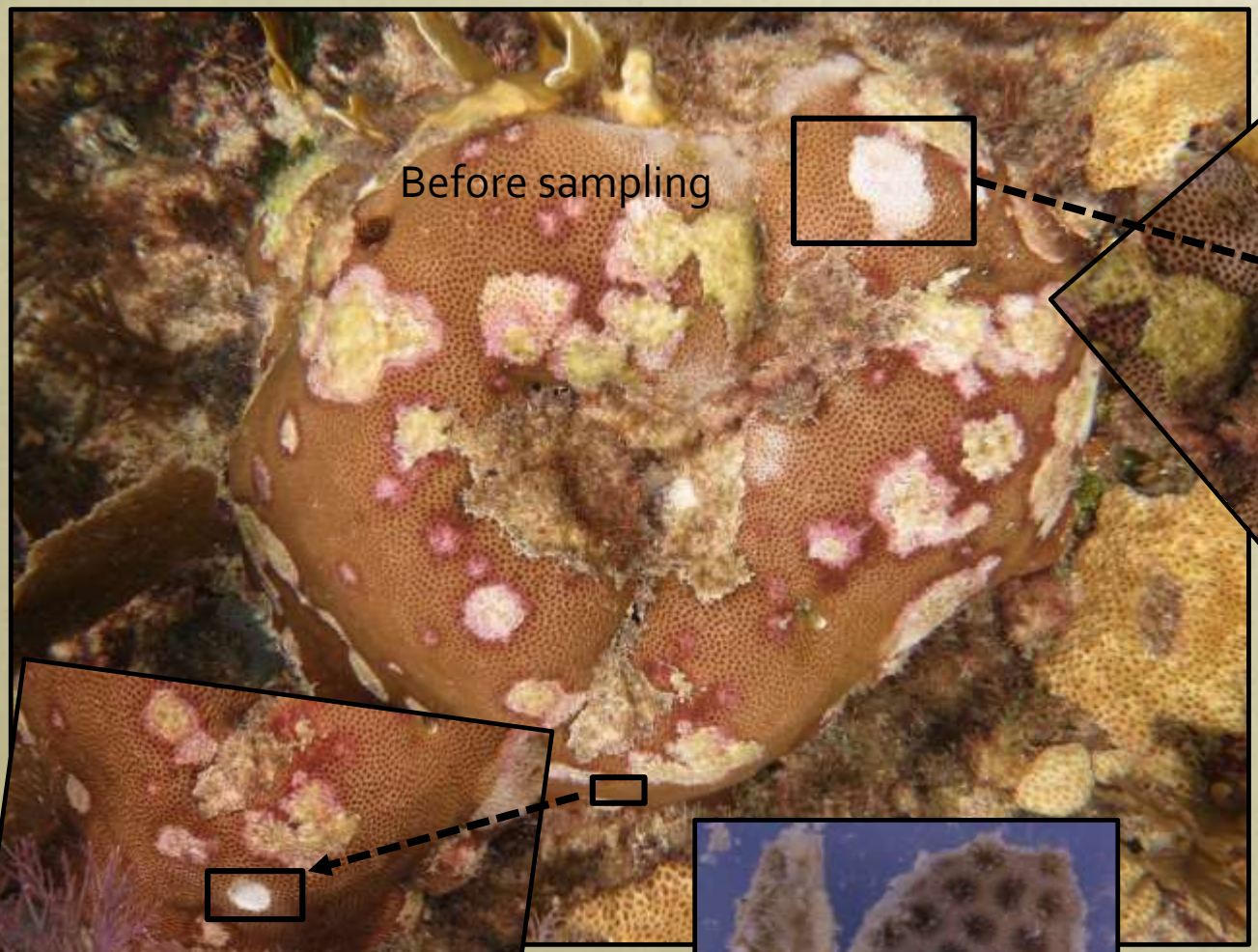
CNAT #15 unaffected sample

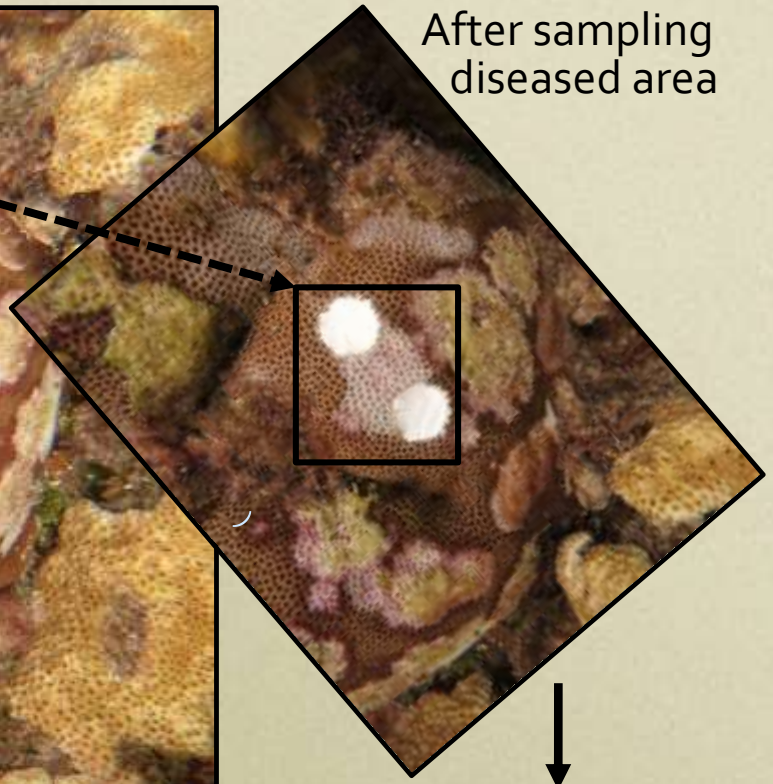


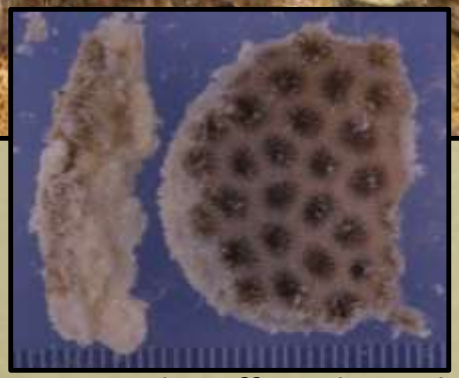
Siboni et al.2010



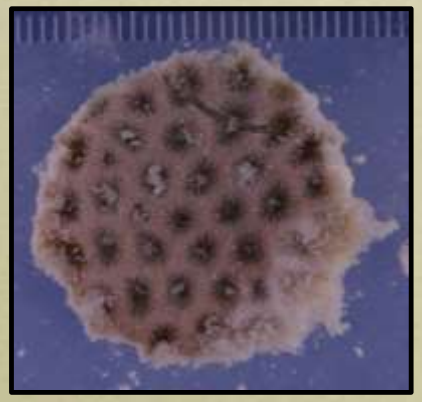
Siderastrea siderea, white blotch (1)



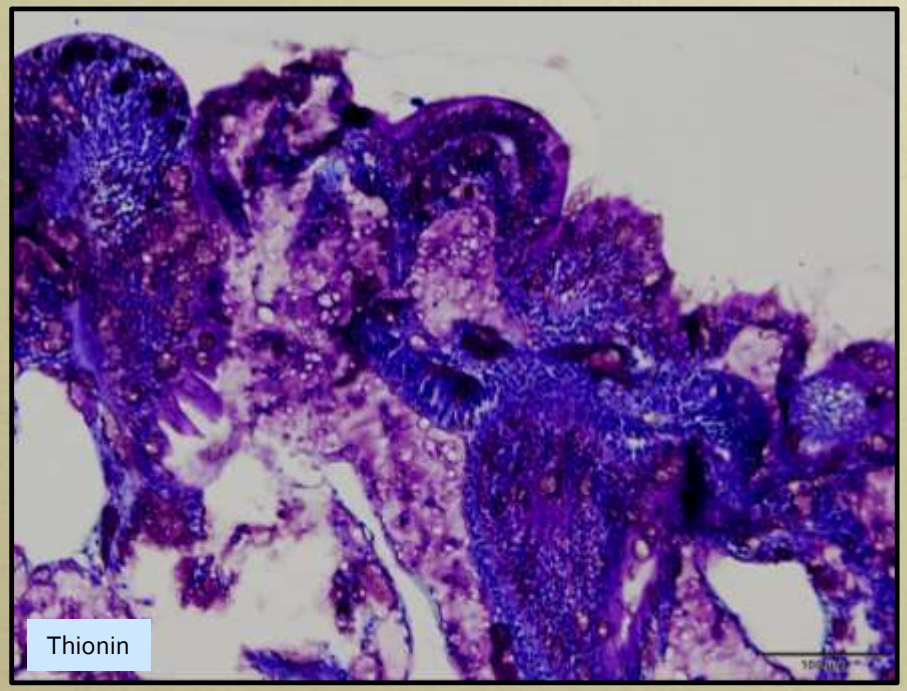


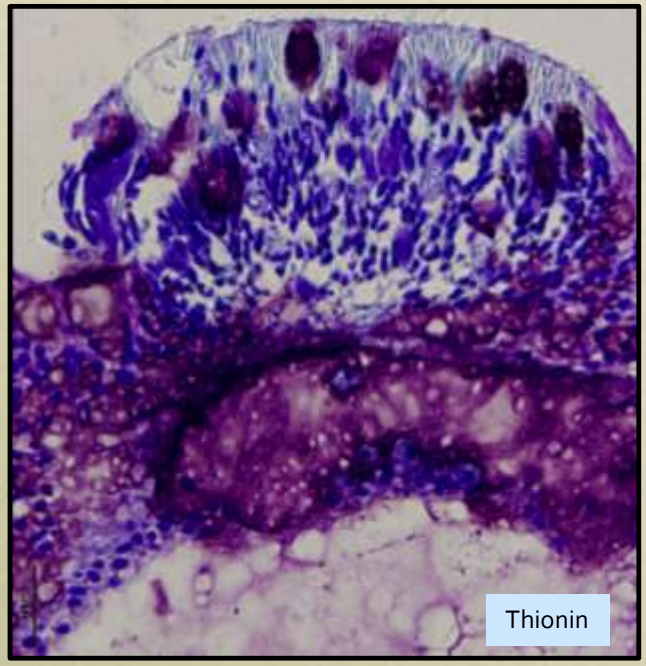

preserved unaffected sample

SSID #19,
7/22/16

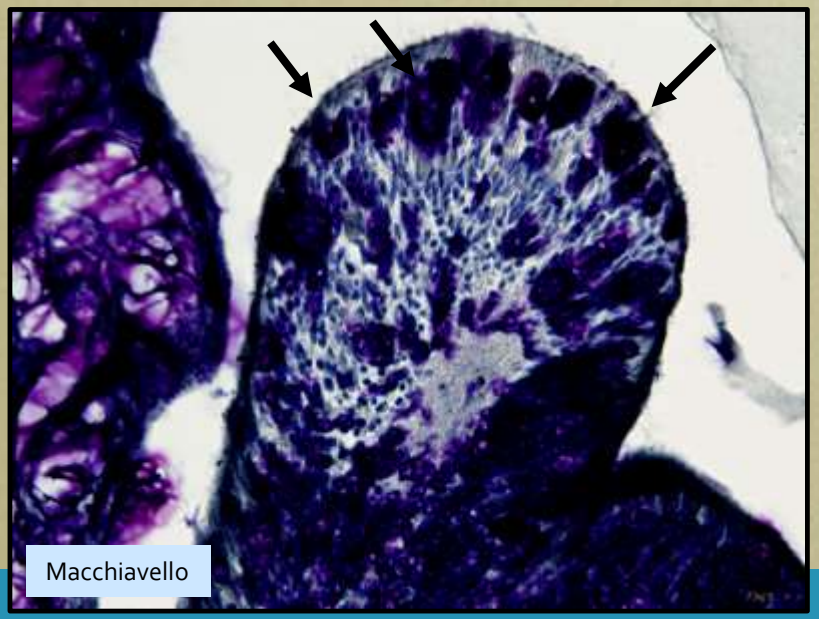

preserved diseased sample

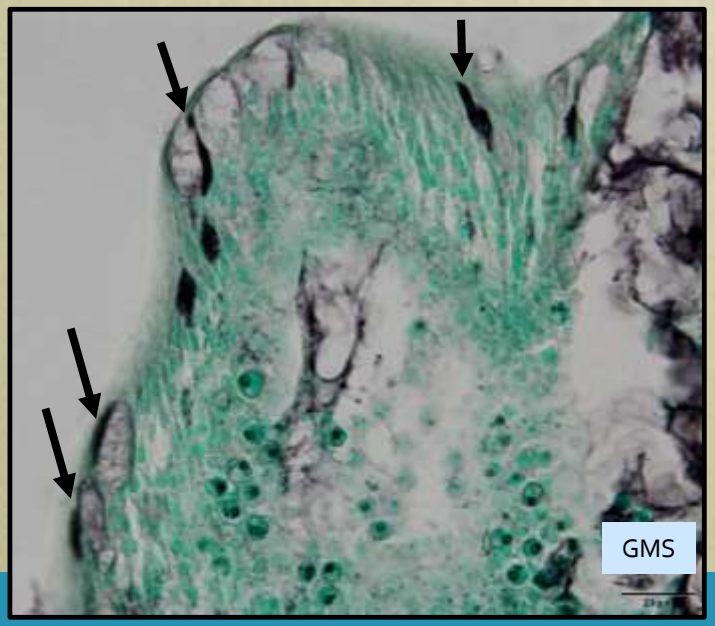
Siderastrea siderea, white blotch (2)



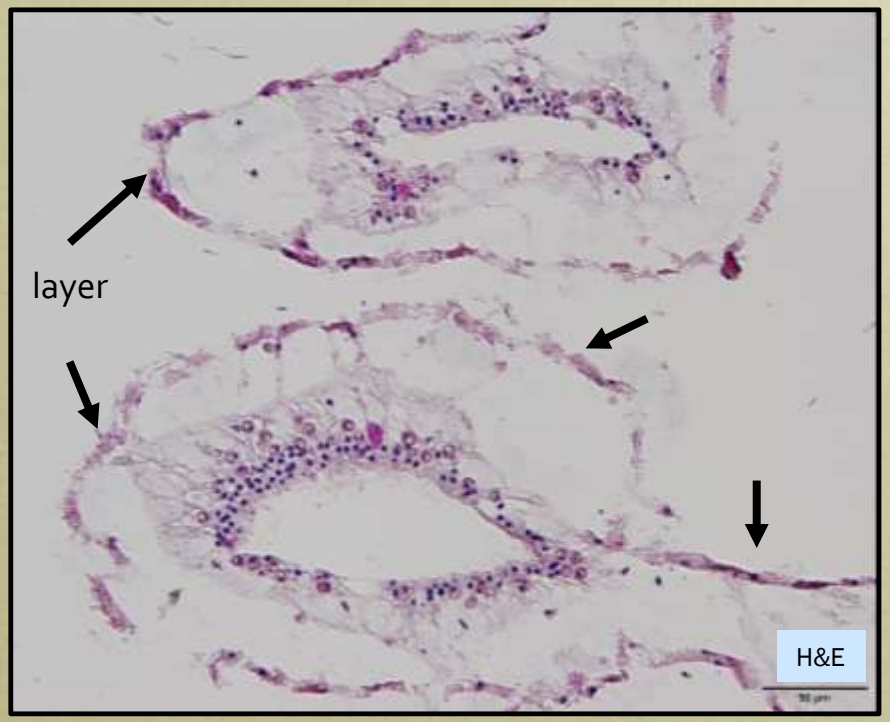


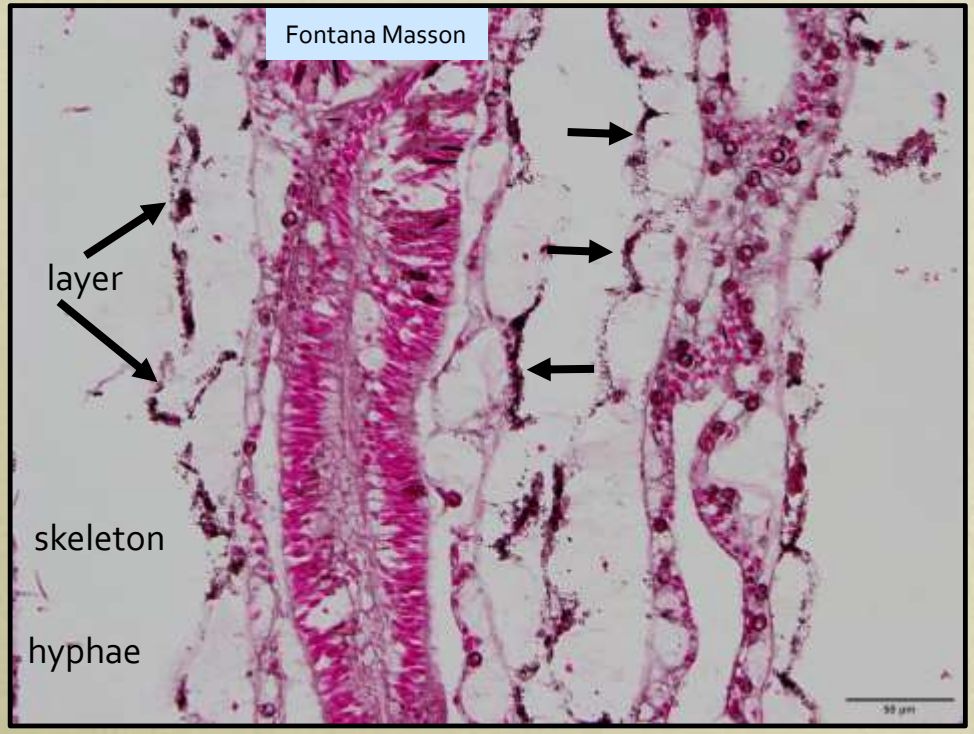
SSID #19, 7/22/16 unaffected sample



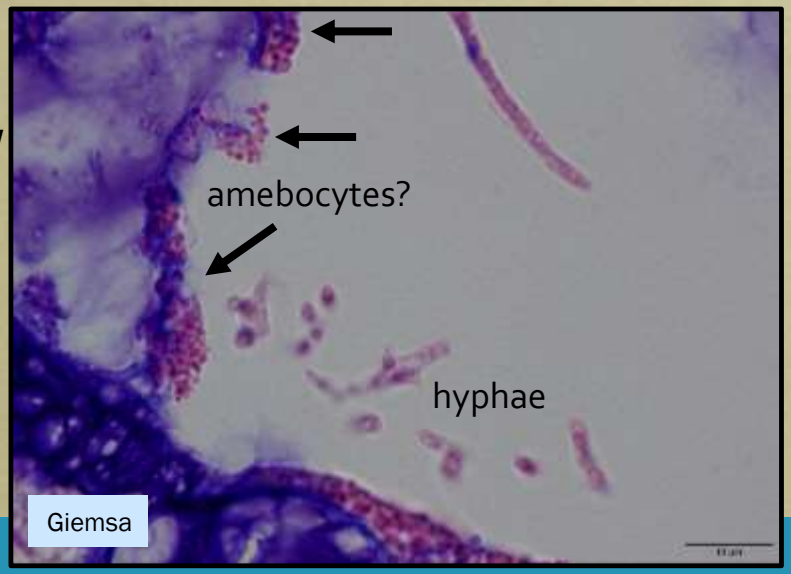


Siderastrea siderea, white blotch (3)

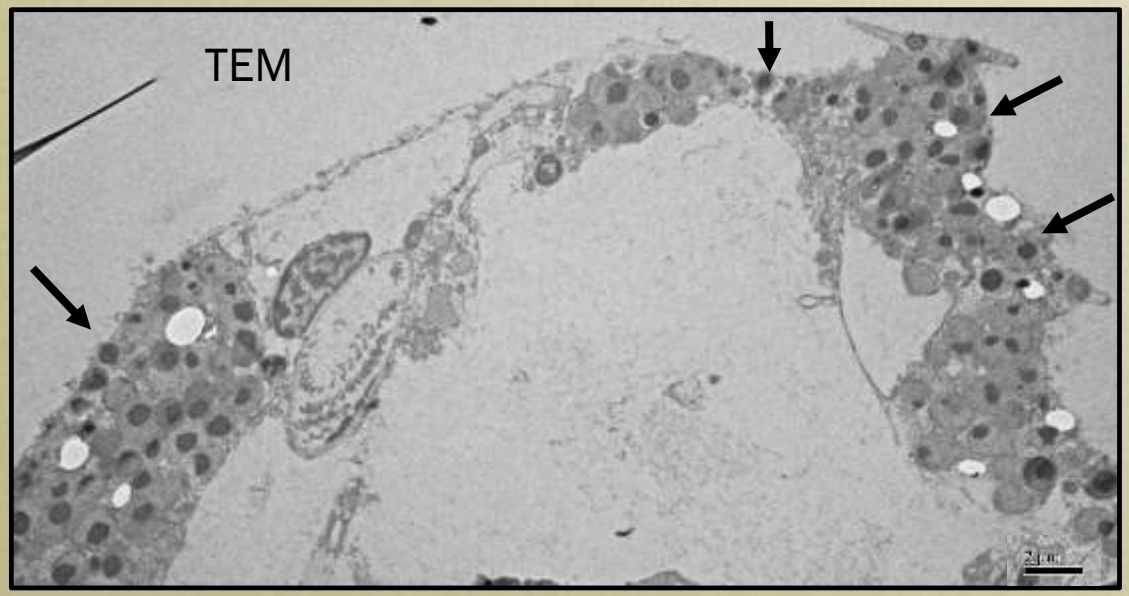




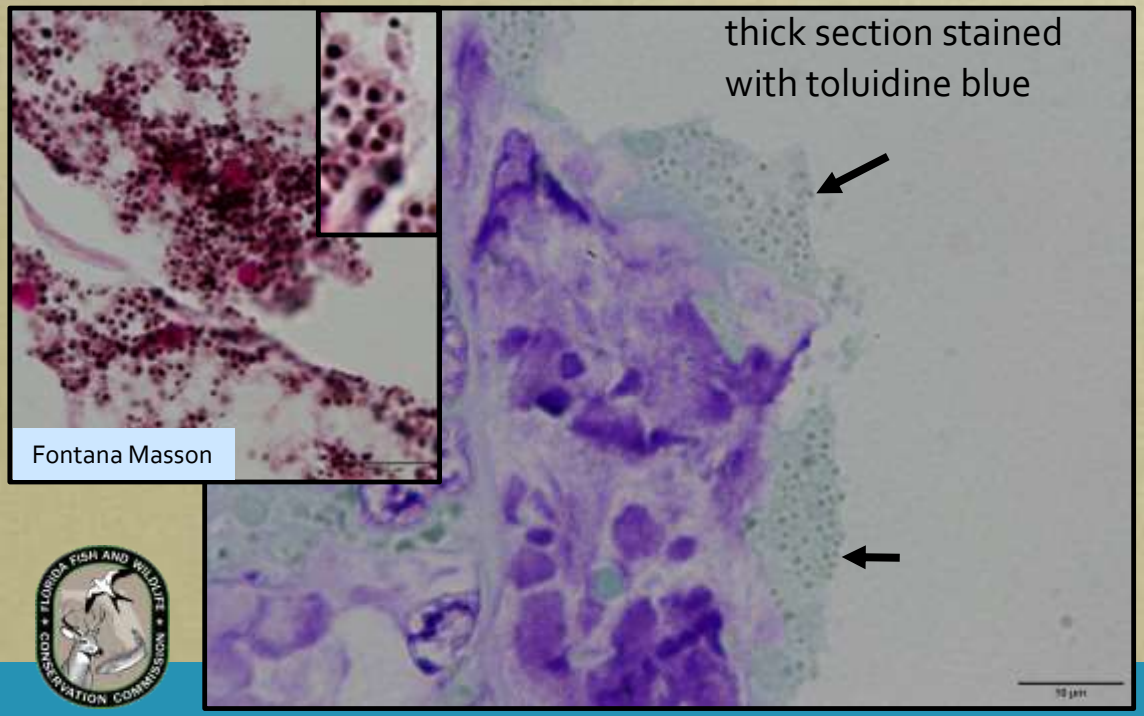
SSID #19, 7/22/16, diseased sample



Siderastrea siderea, white blotch (4)

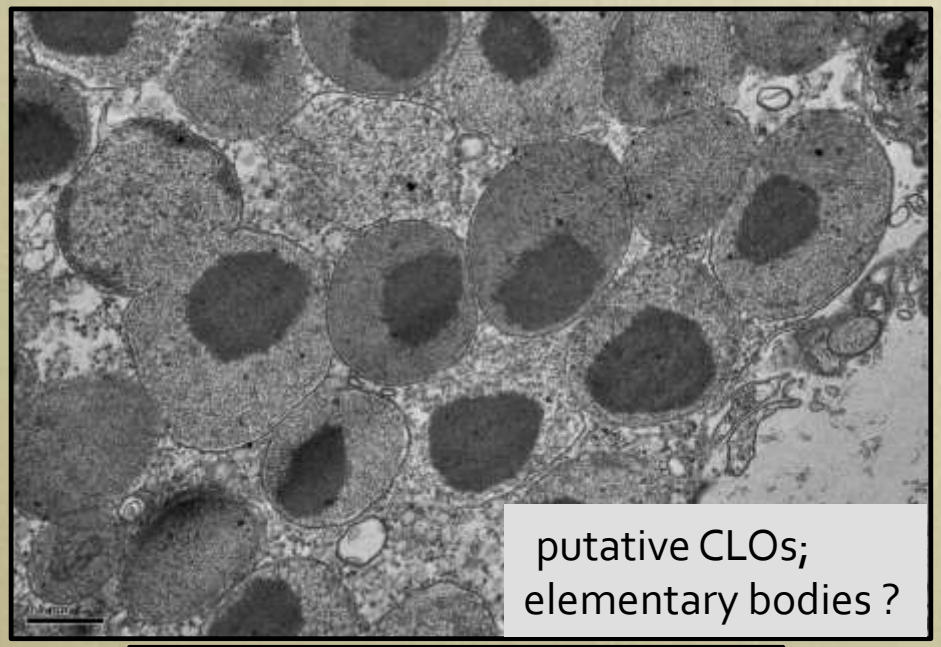


low magnification view of putative CLOs in surface layer

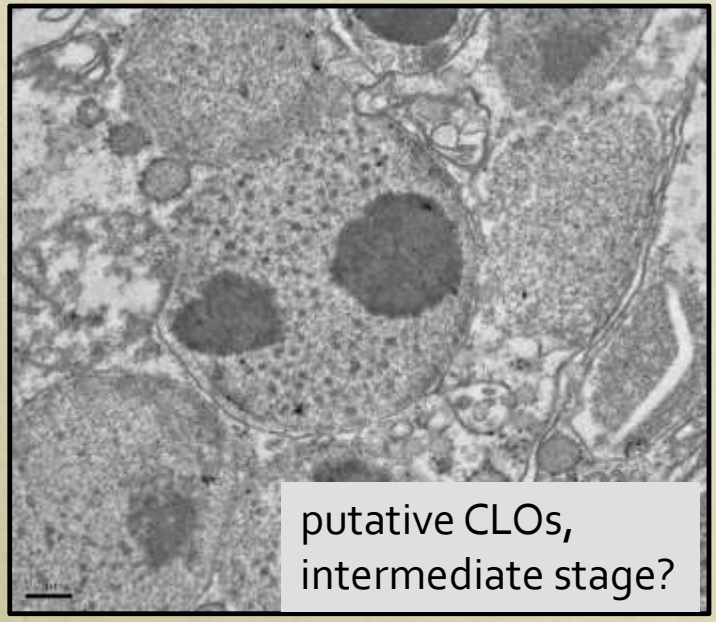


SSID #19,
7/22/16, diseased sample

Siderastrea siderea, white blotch (5)



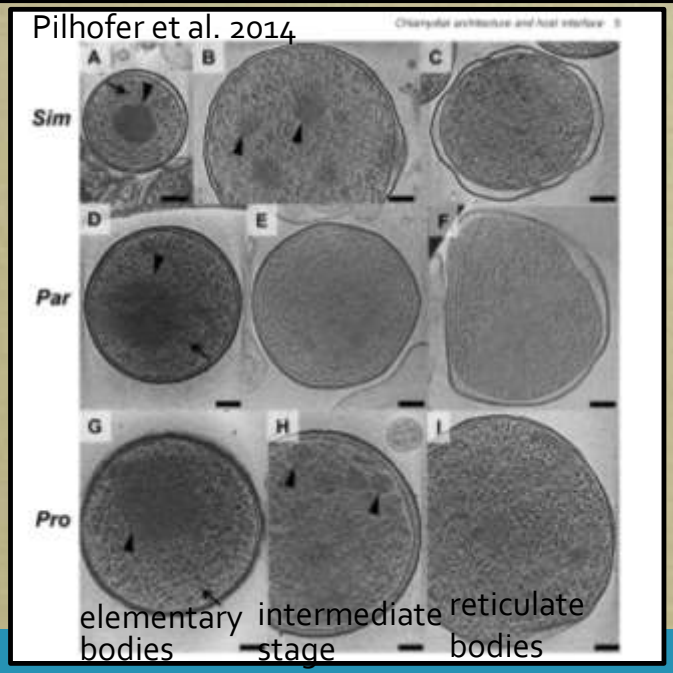
putative CLOs; elementary bodies ?



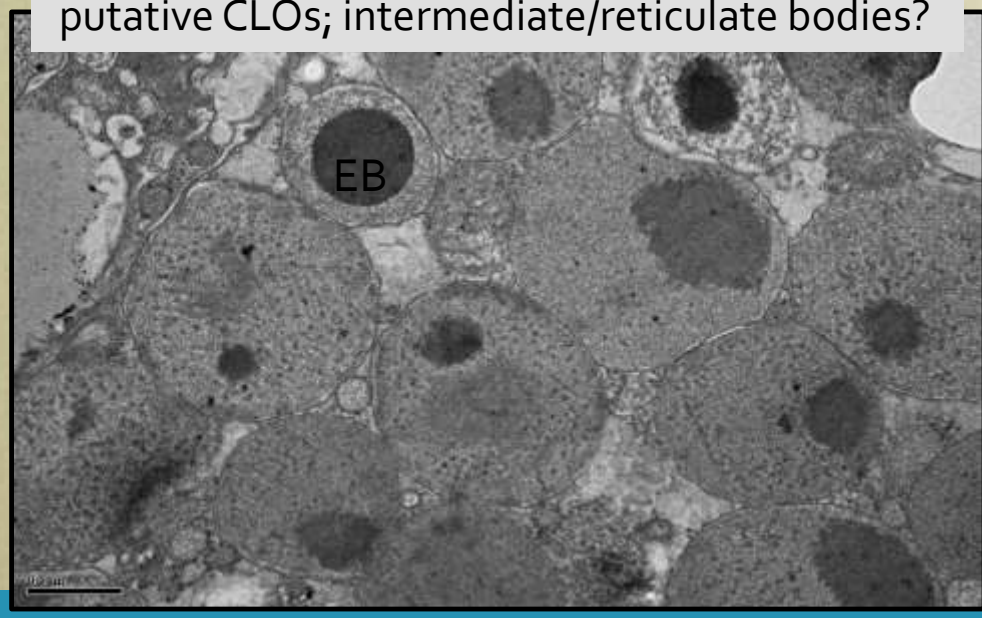
putative CLOs, intermediate stage?

SSID #19, 7/22/16 diseased sample

Pilhofer et al. 2014



putative CLOs; intermediate/reticulate bodies?



Field sampling summary

- samples collected from:
  - Grecian Rocks (FKNMS Upper Keys) (July 2016)
  - SECREMP BC4 (Broward County, November 2016)

Species	White blotch		White plague		Bleaching band		Apparently healthy	
	H	M	H	M	H	M	H	M
S. siderea	6	6					4	4
M. cavernosa	3	3	4	4	6	6	6	6
D. labyrinthiformis	1	1	1	1			1	1
C. natans	3	3					1	1
O. faveolata			2	2	1	1	3	3

H = histology (subset of samples taken for TEM), M = molecular

- Upcoming reference sample collections:
  - SECREMP MC3 (Martin County) April 2017
  - CREMP patch Reef (Middle Keys) May 2017

Histology and TEM summary

- putative CLOs in diseased/unaffected areas of same colonies
  - one associated with mucocytes in the epidermis and cnidoglandular band (*M. cavernosa*, *M. meandrites*, *S. siderea*, *C. natans*) with white plague, white blotch, or bleaching band
  - one epicellular (?) on *S. siderea* (white blotch)
- putative stramenopiles (w/coccoid organisms) in *C. natans*
- endolithic fungi common in multiple coral species
- need molecular identification of symbionts vs potential pathogens
- understand baseline ultrastructure of healthy/diseased coral tissues